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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	Y0999-011 (8728-255)
First Inventor or Application Identifier	Challenger
Title	Method and System for Efficiently...
Express Mail Label No.	EL192802989US

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* (Submit an original and a duplicate for fee processing)

2. [X] Specification [Total Pages 39] (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure

3. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 5]

4. Oath or Declaration [Total Pages 2]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S)
        Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. [ ] Microfiche Computer Program *(Appendix)*

6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [X] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [ ] * Small Entity Statement(s) (PTO/SB/09-12) [ ] Statement filed in prior application, Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [X] Other: Associate Power of Attorney

16. **If a CONTINUING APPLICATION,** *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: _____/_____

Prior application information: Examiner_____ Group / Art Unit_____

For **CONTINUATION or DIVISIONAL APPS only:** The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation **can only** be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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ATTORNEY DOCKET NO. YO999-011 (8728-255)

Date: April 1, 1999

Express Mail Label: EL192802989US

Date of Deposit: April 1, 1999

Transmitted herewith for filing is the Patent Application of:

Inventors: James R. Challenger, Cameron Ferstat, Arun K. Iyengar, Paul Reed, Karen A. Witting

For: METHOD AND SYSTEM FOR EFFICIENTLY CONSTRUCTING AND CONSISTENTLY PUBLISHING WEB DOCUMENTS

Enclosed are: [X] 19 sheets of specification; [X] 1 sheet(s) of Abstract; [X] 19 sheet(s) of claims; [X] 5 sheet(s) of drawing(s)

[X]   An assignment of the invention to International Business Machines Corporation with Recordation Form.

[X]   Declaration and Power of Attorney.

[ ]   A certified copy of a _____ application, from which priority under Title 35 USC §119 is claimed.

[X]   Associate Power of Attorney.

The filing fee has been calculated as shown below:

	(Col. 1)	(Col. 2)		OTHER THAN A SMALL ENTITY	
FOR:	NO. FILED	NO. EXTRA	RATE	FEE	
BASIC FEE				$760.00	
TOTAL CLAIMS	60 -20 =	40	X $18 =	$720.00	
INDEP CLAIMS	5 -3 =	2	X $78 =	$156.00	
MULTIPLE DEPENDENT CLAIMS PRESENTED			+ 260 =		
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[X]   Any additional filing fees required under 37 CFR 1.16.

[X]   Any patent application processing fees under 35 CFR 1.17.

Respectfully submitted,

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METHOD AND SYSTEM FOR EFFICIENTLY CONSTRUCTING AND

CONSISTENTLY PUBLISHING WEB DOCUMENTS

BACKGROUND OF THE INVENTION

5

1. Field of the Invention

The present invention relates to computerized publication of documents, and more particularly to a method for efficiently constructing and consistently publishing

10 documents on the World Wide Web.

2. Description of the Related Art

Web sites often present content which is constantly changing. Presenting consistent information to the outside

15 world without requiring an inordinate amount of computing power is a major technical challenge to Web site designers.

Some of the key consistency constraints for publishing Web pages include the following:

(1) A newly updated Web page should not contain hypertext

20 links to older pages which have not been updated yet.

(2) A newly updated Web page should not contain hypertext

links to pages which have not been created yet.

(3) In many cases, a Web site should not have some of the

pages reflecting current information while other pages

5   reflect older information. Instead, it is desirable to

publish all updated pages containing current information

in one atomic action.

Therefore, a need exists for a system and method for

efficiently constructing documents which provides the

10   capability for updating the documents in accordance with

changes in a consistent and atomic matter.

SUMMARY OF THE INVENTION

A method, which may be implemented by employing a

15   program storage device, for determining an order in which to

construct objects, in accordance with the present invention,

includes the steps of providing a plurality of objects, at

least one of the objects including a relationship with

another object in the plurality of objects, identifying at

20   least one relationship between the plurality of objects,

representing the at least one relationship between the

plurality of objects using at least one graph, and
traversing at least one graph to determine the order in
which to construct objects in accordance with the at least
one relationship and an update to at least one of the

5   objects in the plurality of objects.

In alternate methods, the step of representing the at
least one relationship between the plurality of objects may
include the step of representing objects in the plurality of
objects by nodes and representing the at least one

10   relationship by at least one connection between nodes. The
step of traversing at least one graph to determine the order
may include the step of selecting the order based on one of
performance and correct construction of the plurality of
objects. The step of traversing at least one graph to

15   determine the order may include the step of traversing by
employing at least one topological sort on the at least one
graph. The order may be constructed from the at least one
topological sort. The step of constructing objects may be
based on the order. The step of publishing at least one of

20   the plurality of objects may be included. All of the at
least one of the plurality of objects may be published

together. The step of publishing may include the steps of partitioning the at least one of the plurality of objects into a plurality of groups and publishing all objects belonging to a same group together.

5   In still other methods, the step of publishing all objects belonging to a same group together may include the step of, for at least two of the plurality of groups, publishing all objects belonging to a first group before publishing any objects belonging to a second group. The

10   step of publishing may include the step of satisfying at least one consistency constraint. The step of satisfying at least one consistency constraint may include the step of delaying publication of a first object until a second object which is referenced by the first object is published. The

15   first object and the second object may include Web pages and a reference between the first and second objects may include a hypertext link. The step of satisfying at least one consistency constraint may include the step of publishing two compound objects together if the compound objects are

20   both constructed from at least one common changed fragment.

At least one of the plurality of objects is preferably a Web page.

A method, which may be implemented by employing a program storage device, for publishing a plurality of objects includes the steps of providing a plurality of objects, including compound objects, partitioning at least some of the plurality of objects into a plurality of groups such that if two compound objects are constructed from at least one common changed fragment, then the compound objects are placed in a same group, and publishing all objects belonging to a same group together.

In alternate embodiments, the step of publishing may include the step of, for at least two of the plurality of groups, publishing all objects belonging to a first group before publishing any objects belonging to a second group. The step of publishing may include the step of delaying publication of a first object until a second object which is referenced by the first object is published. The first and the second objects may be Web pages and a reference between the first and the second objects may be a hypertext link. The steps of representing objects by nodes on at least one

graph and representing relationships between the objects by

connections between the nodes may be included. The

connections may include an edge between two nodes

representing compound objects if the two compound objects

5   are constructed from at least one common changed fragment.

The connections may include a directed edge from a first

node representing a first object to a second node

representing a second object, if the second object includes

a reference to the first object. The steps of determining

10   if a first compound object and a second compound object

embed at least one common changed fragment by topologically

sorting at least part of a graph including dependence edges

between objects, determining changed fragments needed to

construct a first object by examining the graph in an order

15   defined by the topological sort and constructing a union

between a second object and changed fragments needed to

construct the second object for at least one edge which

begins with the second object and terminates in the first

object and for which the second object has changed.

20   In still other methods, the step of performing a

topological sort on at least part of the at least one graph

for finding strongly connected components may be included. The steps of examining objects in an order defined by the topological sort, when an unpublished object is examined, publishing the unpublished object together with all objects belonging to a same strongly connected component may also be included.

Another method, which may be implemented by employing a program storage device, for publishing a plurality of objects includes the steps of providing a plurality of objects, constructing at least one graph, the at least one graph including nodes representing objects and edges for connecting nodes having relationships, at least some of the edges being derived from at least one consistency constraint, and finding at least one strongly connected component in the at least one graph.

In alternate embodiments, the step of publishing a set of objects belonging to a same strongly connected component group may be included. The step of topologically sorting at least part of the at least one graph may also be included. The steps of examining objects in an order defined by topological sorting, when an unpublished object is examined,

publishing the unpublished object together with all objects

belonging to a same strongly connected component may be

included. The at least one consistency constraint may

include delaying publication of a first object before a

5   second object which is referenced by the first object is

published. The objects may include Web pages and at least

one edge between the objects may correspond to at least one

hypertext link. An edge may exist from a first object to a

second object in at least one of the at least one graphs if

10   the second object has a reference to the first object. At

least one of the consistency constraints may include

publishing two compound objects together if the two compound

objects are both constructed from at least one common

changed fragment.

15   These and other objects, features and advantages of the

present invention will become apparent from the following

detailed description of illustrative embodiments thereof,

which is to be read in connection with the accompanying

drawings.

20

BRIEF DESCRIPTION OF DRAWINGS

The invention will be described in detail in the following description of preferred embodiments with reference to the following figures wherein:

FIG. 1 is a block diagram showing relationships among a set of fragments and compound objects.

FIG. 2 is a block/flow diagram of a system/method for efficiently constructing and publishing objects in accordance with the present invention;

FIG. 3 is a block diagram showing a relationship between a set of fragments and compound objects in accordance with the present invention;

FIG. 4 is an object dependence graph (ODG) corresponding according to FIG. 3, in accordance with the present invention; and

FIG. 5 is a flow diagram for a method for consistently publishing objects in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

This invention presents a system and method for publishing documents, for example Web documents, efficiently

and consistently. This method may be used at a wide variety

of Web sites of the World Wide Web. The present invention

may be applied to systems outside the Web as well, for

example, where compound objects are constructed from

5   fragments. A fragment is an object which is used to

construct a compound object. An object is an entity which

can either be published or is used to create something which

is publishable. Objects include both fragments and compound

objects. A compound object is an object constructed from

10   one or more fragments.

In generating Web content, publishable Web pages known

as servables may be constructed from simpler fragments. A

servable is a complete entity which may be published at a

Web site. Publishing an object means making it visible to

15   the public or a community of users. Publishing is decoupled

from creating or updating an object and generally takes

place after the object has been created or updated. It is

possible for a servable to embed a fragment which in turn

embeds another fragment, etc.

While fragments significantly increase the capabilities of a Web site, a number of problems may arise which need to be solved, including the following:

(1)   When changes to underlying data occur, how does the system determine all objects affected by the change?

(2)   How does the system determine a correct and efficient order for updating fragments and servables?

(3)   How can a system consistently publish Web pages in the presence of fragments?   For an illustrative example, refer to FIG. 1.   Suppose that servables S1 and S2 both embed the same fragment f1.   If f1 changes, updated versions of S1 and S2 must be published concurrently; otherwise, the site will look inconsistent.   However, the consistency problem is worse than just determining if a set of pages all embed the same fragment.   For example, suppose S1 and S3 both embed fragment f2. If f2 changes, updated versions of both S1 and S3 must be published concurrently.   However, if both f1 and f2 change, updated versions of S1, S2, and S3 must be published concurrently, even though S2 and S3 might not embed a common fragment.

A method for solving problem (1) is described in a commonly assigned patent application, U.S. Serial No. 08/905,114, entitled "Determining How Changes to Underlying Data Affect Cached Objects" by J. Challenger, P. Dantzig, A. Iyengar, and G. Spivak. The current invention solves problems (2) and (3).

It should be understood that the elements shown in FIGS. 2 and 5 may be implemented in various forms of hardware, software or combinations thereof unless otherwise specified. Preferably, these elements are implemented in software on one or more appropriately programmed general purpose digital computers having a processor and memory and input/output interfaces. Referring now to the drawings in which like numerals represent the same or similar elements and initially to FIG. 2, a block/flow diagram of a system/method for efficiently constructing and publishing one or more servables in accordance with the present invention is shown. In block 100, the system maintains an object dependence graph (ODG) which is a directed graph with objects corresponding to nodes/vertices in the graph. A dependence edge from a to b, for example, indicates that a

change to object a also affects object b. The edge also
implies that a should be updated before b after a change
which affects the values of both a and b occurs.

Dependence edges may preferably be used to identify the
5   following:

a.   The objects affected by a change to underlying data.

b.   The order in which objects are desired or needed to
be updated.

In one illustrative example, FIG. 3 depicts 3 Web
10   pages, P1, P2, and P4. P3 is a fragment embedded in P1 and
P2. Similarly, P0 is a fragment embedded in P4. An arrow
"A" from P1 to P4 indicates that P1 has a hypertext link to
P4. In the illustrative example, FIG. 4 depicts an object
dependence graph (ODG) corresponding to the objects in FIG.
15   3. The ODG indicates that any change to P0 also changes the
value of P4. It also indicates that any change to P3 also
changes both P1 and P2. Since P4 includes P0, P0 should be
constructed before P4 when P0 changes. Similarly, P3 should
be updated before both P1 and P2 when P3 changes.

20   Whenever objects change, the system is notified in
block 110. The system will be notified of a set of objects

C which have changed. Changes to objects in C will often imply changes to other objects as well; the system applies graph traversal algorithms to detect all objects which have changed and an efficient order (or partial order) for computing changed objects. In block 120, a set of all objects S affected by the change is determined by a topological sort (or partial sort)of all (or some) nodes reachable from C by following edges in the ODG. Topological sorting of S orders the vertices so that whenever there is a path from a to b, a appears before b. A topological sorting algorithm is presented in *Introduction to Algorithms* by Cormen, Leiserson, and Rivest, MIT Press, 1990, Cambridge, MA, incorporated herein by reference. Other topological algorithms may also be employed.

In block 130, objects in S are updated in an order consistent with the topological sort performed in block 120. In block 140, objects are published. In one method, all servables are published in S concurrently. This avoids consistency problems. Another method publishes some servables in S before others, i.e. incremental publication.

There are a number of reasons why incremental publication
may be desirable. These reasons may include:

(1) In a number of environments, publishing documents after
the documents are updated may be time-consuming.

5   Incremental publication may make certain documents available
sooner than would be the case using the all-at-once
approach.

(2) It is conceivable that some environments may have
constraints on the number of documents which can be

10   published atomically. The incremental approach reduces the
number of documents which need to be published in single
atomic actions.

      Incremental publishing may be more difficult to
implement than the all-at-once approach because of the need

15   to satisfy consistency constraints such as the ones
described earlier.

      Referring to FIG. 5, a method for incrementally
publishing objects, for example, Web pages, which satisfies
one or more consistency constraints described earlier is

20   shown. In step 410, a consistency graph is created which
includes servables as vertices/nodes. Edges of the

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consistency graph are referred to as consistency edges. A
consistency edge from a servable c to another servable d
indicates that d should not be published before c.
Consistency edges do not imply the order in which c and d
are be generated. A consistency edge exists if there were a
hypertext link from d to c and both d and c are in S. Such
a link does not imply that c must be constructed before d,
only that c should be published before or concurrently with
d. It is entirely possible that data dependence edges
indicate that d should be constructed before c even though c
should be published before or at the same time as d.

Consistency edges are also used to indicate that two
servables both embed a common fragment whose value has
changed and thus are to be published concurrently. If c and
d both embed a common fragment whose value has changed, then
a consistency edge from c to d and d to c should exist.

It is now explained how to determine whether two
servables both embed a common changed fragment. As a node a
in S is constructed in the order defined by the topological
sort in block 130, a set of comprising-nodes is computed for
a. Comprising-nodes(a) includes identifiers for nodes in S

which affect the value of a. Comprising-nodes(a) is the

union of b and comprising-nodes(b) for edges (b,a) which

terminate in a where b is a member of S.

A directed graph T is now created including servables

in S (S is the set of all objects which have changed)and

consistency edges. For two servables a and b in S, an edge

from a to b exists in T if:

(1) A hypertext link from b to a exists, or

(2) a and b both embed a common changed fragment. This is

true if comprising-nodes(a) and comprising-nodes(b) have a

node in common. In this case, a consistency edge from both

a to b and b to a exist.

In step 420, graph traversal algorithms are used on T

to topologically sort T and find its strongly connected

components. A strongly connected component of T is a

maximal subset of vertices T' such that every vertex in T'

has a directed path to every other vertex in T'. The

previously cited book, *Introduction to Algorithms*, by

Cormen, et al. includes an algorithm for finding

strongly connected components. Other algorithms for finding

strongly connected components may also be employed. Each

strongly connected component of T corresponds to a set of servables which can be published together.

In step 430, servables are published in the following order: Examine servables of T in topological sorting order. For a servable a of T, if a was part of a previously published strongly connected component, go to the next servable. Otherwise, publish all servables corresponding to the strongly connected component including a in an atomic action.

An extension of this algorithm may be to use either more or fewer consistency constraints in the method depicted in FIG 5. Another extension may be to enhance the method to try to prevent publication of pages with broken hypertext links. The present invention may be extended to the publication of documents including but not limited to Web pages.

A quick publishing and censoring system and method which may be used is described in "METHOD AND SYSTEM FOR RAPID PUBLISHING AND CENSORING INFORMATION", Attorney docket number YO999-040(8728-253), filed concurrently herewith, commonly assigned and incorporated herein by reference. A

system and method which may be used for publishing web
documents is described in "METHOD AND SYSTEM FOR PUBLISHING
DYNAMIC WEB DOCUMENTS", Attorney docket number YO999-
039(8728-254), filed concurrently herewith, commonly

5   assigned and incorporated herein by reference.

Having described preferred embodiments of a system and
method for efficiently constructing and consistently
publishing web documents (which are intended to be
illustrative and not limiting), it is noted that

10   modifications and variations can be made by persons skilled
in the art in light of the above teachings. It is therefore
to be understood that changes may be made in the particular
embodiments of the invention disclosed which are within the
scope and spirit of the invention as outlined by the

15   appended claims. Having thus described the invention with
the details and particularity required by the patent laws,
what is claimed and desired protected by Letters Patent is
set forth in the appended claims.

<u>WHAT IS CLAIMED IS</u>:

1. A method for determining an order in which to construct objects comprising the steps of:

5   providing a plurality of objects, at least one of the objects including a relationship with another object in the plurality of objects;

identifying at least one relationship between the plurality of objects;

10   representing the at least one relationship between the plurality of objects using at least one graph; and

traversing at least one graph to determine the order in which to construct objects in accordance with the at least one relationship and an update to at least one of the

15 objects in the plurality of objects.

2. The method as recited in claim 1, wherein the step of representing the at least one relationship between the plurality of objects includes the step of representing

20 objects in the plurality of objects by nodes and

representing the at least one relationship by at least one

connection between nodes.

3. The method as recited in claim 1, wherein the step

of traversing at least one graph to determine the order

includes the step of selecting the order based on one of

performance and correct construction of the plurality of

objects.

4. The method as recited in claim 1, wherein the step

of traversing at least one graph to determine the order

includes the step of traversing by employing at least one

topological sort on the at least one graph.

5. The method as recited in claim 4, wherein the

order is constructed from the at least one topological sort.

6. The method as recited in claim 1, further

comprising the step of constructing objects based on the

order.

7.   The method as recited in claim 1, further comprising the step of publishing at least one of the plurality of objects.

5   8.   The method as recited in claim 7, wherein all of the at least one of the plurality of objects are published together.

          9.   The method as recited in claim 7, wherein the step
10   of publishing includes the steps of:

          partitioning the at least one of the plurality of objects into a plurality of groups; and

          publishing all objects belonging to a same group together.

15

          10.   The method as recited in claim 9 wherein the step of publishing all objects belonging to a same group together includes the step of:

          for at least two of the plurality of groups, publishing
20   all objects belonging to a first group before publishing any objects belonging to a second group.

11.   The method as recited in claim 7, wherein the step
of publishing includes the step of satisfying at least one
consistency constraint.

5   12.   The method as recited in claim 11, wherein the
step of satisfying at least one consistency constraint
includes the step of delaying publication of a first object
until a second object which is referenced by the first
object is published.

10

13.   The method as recited in claim 12, wherein the
first object and the second object include Web pages and a
reference between the first and second objects includes a
hypertext link.

15

14.   The method as recited in claim 11, wherein the
step of satisfying at least one consistency constraint
includes the step of publishing two compound objects
together if the compound objects are both constructed from
20   at least one common changed fragment.

15. The method as recited in claim 1, wherein at least one of the plurality of objects is a Web page.

16. A method for publishing a plurality of objects comprising the steps of:

providing a plurality of objects, including compound objects;

partitioning at least some of the plurality of objects into a plurality of groups such that if two compound objects are constructed from at least one common changed fragment, then the compound objects are placed in a same group; and

publishing all objects belonging to a same group together.

17. The method as recited in claim 16, wherein the step of publishing includes the step of:

for at least two of the plurality of groups, publishing all objects belonging to a first group before publishing any objects belonging to a second group.

18. The method as recited in claim 16, wherein the step of publishing includes the step of:

delaying publication of a first object until a second object which is referenced by the first object is published.

5

19. The method as recited in claim 18, wherein the first and the second objects are Web pages and a reference between the first and the second objects is a hypertext link.

10

20. The method as recited in claim 16, further comprising the steps of:

representing objects by nodes on at least one graph; and

15 representing relationships between the objects by connections between the nodes.

21. The method as recited in claim 20, wherein the connections include an edge between two nodes representing

20 compound objects if the two compound objects are constructed from at least one common changed fragment.

22. The method as recited in claim 20, wherein the connections include a directed edge from a first node representing a first object to a second node representing a second object, if the second object includes a reference to

5   the first object.

23. The method of claim 20, further comprising the steps of:

determining if a first compound object and a second

10   compound object embed at least one common changed fragment by:

topologically sorting at least part of a graph including dependence edges between objects;

determining changed fragments needed to construct

15   a first object by:

examining the graph in an order defined by the topological sort; and

constructing a union between a second object and changed fragments needed to construct the second object

20   for at least one edge which begins with the second object

and terminates in the first object and for which the second

object has changed.

24. The method as recited in claim 20 further

comprising the step of performing a topological sort on at

least part of the at least one graph for finding strongly

connected components.

25. The method as recited in claim 24, further

comprising the step of publishing a set objects belonging to

a same strongly connected component, of the at least one

graph, together.

26. The method as recited in claim 24, further

comprising the steps of:

examining objects in an order defined by the

topological sort;

when an unpublished object is examined, publishing the

unpublished object together with all objects belonging to a

same strongly connected component.

27. A program storage device readable by machine,

tangibly embodying a program of instructions executable by

the machine to perform method steps for determining an order

in which to construct a plurality of objects, the method

5   steps comprising:

providing a plurality of objects, at least one of the

objects including a relationship with another object in the

plurality of objects;

identifying at least one relationship between the

10   plurality of objects;

representing the plurality of objects and the at least

one relationship between the plurality of objects using at

least one graph; and

traversing at least one graph to determine the order in

15   which to construct objects in accordance with the at least

one relationship and an update to at least one of the

objects in the plurality of objects.

28. The program storage device as recited in claim 27,

20   wherein the step of graphically representing the at least

one relationship between the plurality of objects includes

the step of representing objects in the plurality of objects

by a node and representing the at least one relationship by

a connection between nodes.

5   29.   The program storage device as recited in claim 27,

wherein the step of traversing at least one graph to

determine the order includes the step of selecting the order

based on one of performance and correct construction of the

plurality of objects.

10

30.   The program storage device as recited in claim 27,

wherein the step of traversing at least one graph to

determine the order includes the step of traversing by

employing at least one topological sort on at least part of

15   the at least one graph.

31.   The program storage device as recited in claim 30,

wherein the order is constructed from the at least one

topological sort.

20

32. The program storage device as recited in claim 27, further comprising the step of constructing the plurality of objects based on the order.

5

33. The program storage device as recited in claim 27, further comprising the step of publishing at least one of the plurality of objects.

34. The program storage device as recited in claim 33,

10 wherein all of the at least one of the plurality of objects are published together.

35. The program storage device as recited in claim 33, wherein the step of publishing includes the steps of:

15   partitioning the at least one of the plurality of objects into a plurality of groups; and

publishing all objects belonging to a same group together.

36. The program storage device as recited in claim 35 wherein the step of publishing all objects belonging to a same group together includes the step of:

for at least two of the plurality of groups, publishing all objects belonging to a first group before publishing any objects belonging to a second group.

37. The program storage device as recited in claim 33, wherein the step of publishing includes the step of satisfying at least one consistency constraint.

38. The program storage device as recited in claim 37, wherein the step of satisfying at least one consistency constraint includes the step of delaying publication of a first object until a second object which is referenced by the first object is published.

39. The program storage device as recited in claim 38, wherein the first object and the second object include Web

pages and a reference between the first and second objects
includes a hypertext link.

40. The program storage device as recited in claim 37,
wherein the step of satisfying at least one consistency
constraint includes the step of publishing two compound
objects together if the compound objects are both
constructed from at least one common changed fragment.

41. The program storage device as recited in claim 27,
wherein at least one of the plurality of objects is a Web
page.

42. A program storage device readable by machine,
tangibly embodying a program of instructions executable by
the machine to perform method steps for publishing a
plurality of objects, the method steps comprising:

providing a plurality of objects, including compound
objects;

partitioning at least some of the plurality of objects
into a plurality of groups such that if two compound objects

are constructed from at least one common changed fragment,

then the compound objects are placed in a same group; and

publishing all objects belonging to a same group

together.

5

43.   The program storage device as recited in claim 42,

wherein the step of publishing includes the step of:

for at least two of the plurality of groups, publishing

all objects belonging to a first group before publishing any

10   objects belonging to a second group.

44.   The program storage device as recited in claim 42,

wherein the step of publishing includes the step of:

delaying publication of a first object until a second

15   object which is referenced by the first object is published.

45.   The program storage device as recited in claim 44,

wherein the first and the second objects are Web pages and a

reference between the first and second objects is a

20   hypertext link.

46.   The program storage device as recited in claim 44,
further comprising the steps of:

representing objects by nodes on at least one graph;
and

5   representing relationships between the objects by
connections between the nodes.

47.   The program storage device as recited in claim 46,
wherein the connections include an edge between two nodes
10   representing compound objects if two compound objects are
constructed from at least one common changed fragment.

48.   The program storage device as recited in claim 46,
wherein the connections include a directed edge from a first
15   node representing a first object to a second node
representing a second object, if the second object includes
a reference to the first object.

49.   The program storage device of claim 46, further
20   comprising the steps of:

determining if a first compound object and a second

compound object embed at least one common changed fragment

by:

topologically sorting a graph including dependence

5   edges between objects;

determining changed fragments needed to construct

a first object by:

examining the graph in an order defined by

the topological sort; and

10   constructing a union between a second object

and changed fragments needed to construct the second object

for at least one edge which begins with the second object

and terminates in the first object and for which the second

object has changed.

15

50.   The program storage device as recited in claim 46,

further comprising the step of performing a topological sort

on at least part of the at least one graph for finding

strongly connected components.

20

51. The program storage device as recited in claim 50,
further comprising the step of publishing a set objects
belonging to a same strongly connected component, of the at
least one graph, together.

5

52. The method as recited in claim 50, further
comprising the steps of:

examining objects in an order defined by the
topological sort;

10   when an unpublished object is examined, publishing the
unpublished object together with all objects belonging to a
same strongly connected component.

53. A method for publishing a plurality of objects
15 comprising the steps of:

providing a plurality of objects;

constructing at least one graph, the at least one graph
including nodes representing objects and edges for
connecting nodes having relationships, at least some of the
20 edges being derived from at least one consistency
constraint; and

finding at least one strongly connected component in
the at least one graph.

54. The method as recited in claim 53, further
comprising the step of publishing a set of objects belonging
to a same strongly connected component group.

55. The method as recited in claim 53, further
comprising the step of topologically sorting at least part
of the at least one graph.

56. The method as recited in claim 55, further
comprising the steps of:

examining objects in an order defined by topological
sorting;

when an unpublished object is examined, publishing the
unpublished object together with all objects belonging to a
same strongly connected component.

57. The method as recited in claim 53, wherein one of
the at least one consistency constraint includes delaying

publication of a first object before a second object which
is referenced by the first object is published.

58. The method as recited in claim 57, wherein the
first and second objects include Web pages and at least one
edge between the objects corresponds to at least one
hypertext link.

59. The method as recited in claim 53, wherein an edge
exists from a first object to a second object in at least
one of the at least one graphs if the second object has a
reference to the first object.

60. The method as recited in claim 53, wherein at
least one of the consistency constraints includes publishing
two compound objects together if the two compound objects
are both constructed from at least one common changed
fragment.

METHOD AND SYSTEM FOR EFFICIENTLY CONSTRUCTING AND

CONSISTENTLY PUBLISHING WEB DOCUMENTS

ABSTRACT OF THE DISCLOSURE

5   A method, which may be implemented by employing a

program storage device, for determining an order in which to

construct objects, in accordance with the present invention,

includes the steps of providing a plurality of objects, at

least one of the objects including a relationship with

10   another object in the plurality of objects, identifying at

least one relationship between the plurality of objects,

representing the at least one relationship between the

plurality of objects using at least one graph, and

traversing at least one graph to determine the order in

15   which to construct objects in accordance with the at least

one relationship and an update to at least one of the

objects in the plurality of objects.

20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT(S): James R.H. Challenger, Cameron Ferstat, Arun K. Iyengar, Paul Reed, Karen A. Witting

SERIAL NO.: Unassigned

FILED: Concurrently herewith

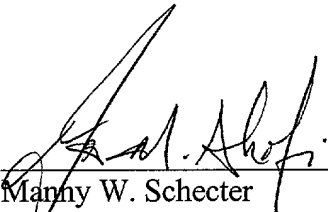**FOR:** METHOD AND SYSTEM FOR EFFICIENTLY CONSTRUCTING AND CONSISTENTLY PUBLISHING WEB DOCUMENTS

ASSOCIATE POWER OF ATTORNEY

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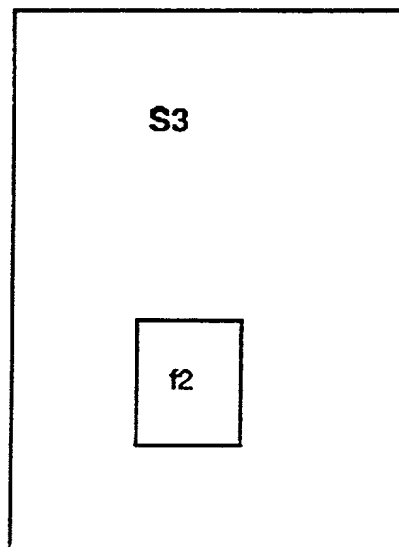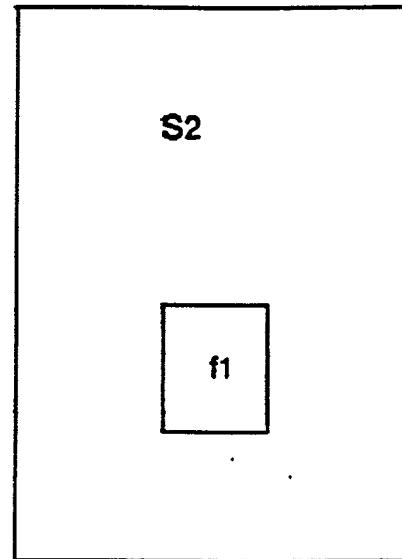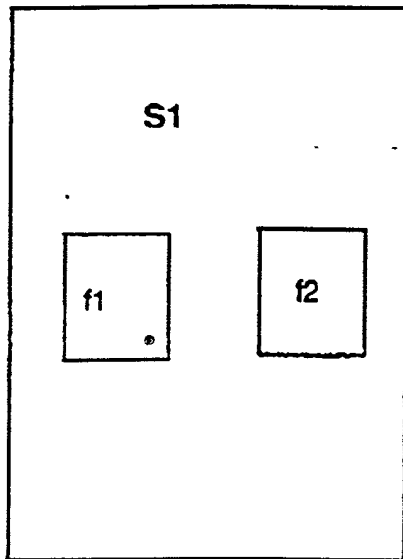Attorney for Applicant(s)

Challenger et al.
Y0999-011 (DMS)(8728-255)

FIG. 1

System Maintains
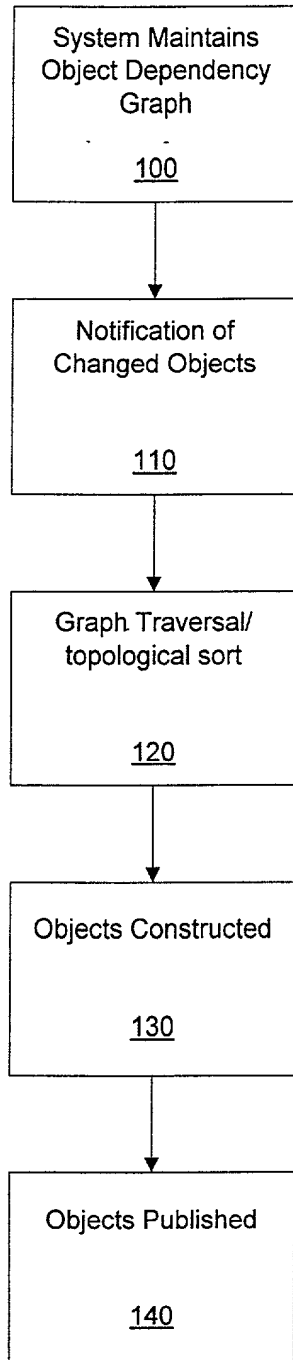Object Dependency
Graph

100

Notification of
Changed Objects

110

Graph Traversal/
topological sort

120

FIG. 2

Objects Constructed

130

Objects Published

140

FIG. 3

FIG. 4

Create Consistency Graph

410

Topological sort/ find strongly connected components

420

Publish according to strongly connected components

430
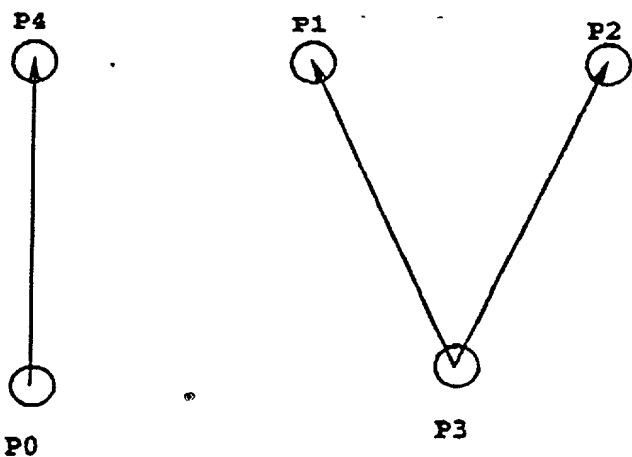
FIG. 5

DECLARATION
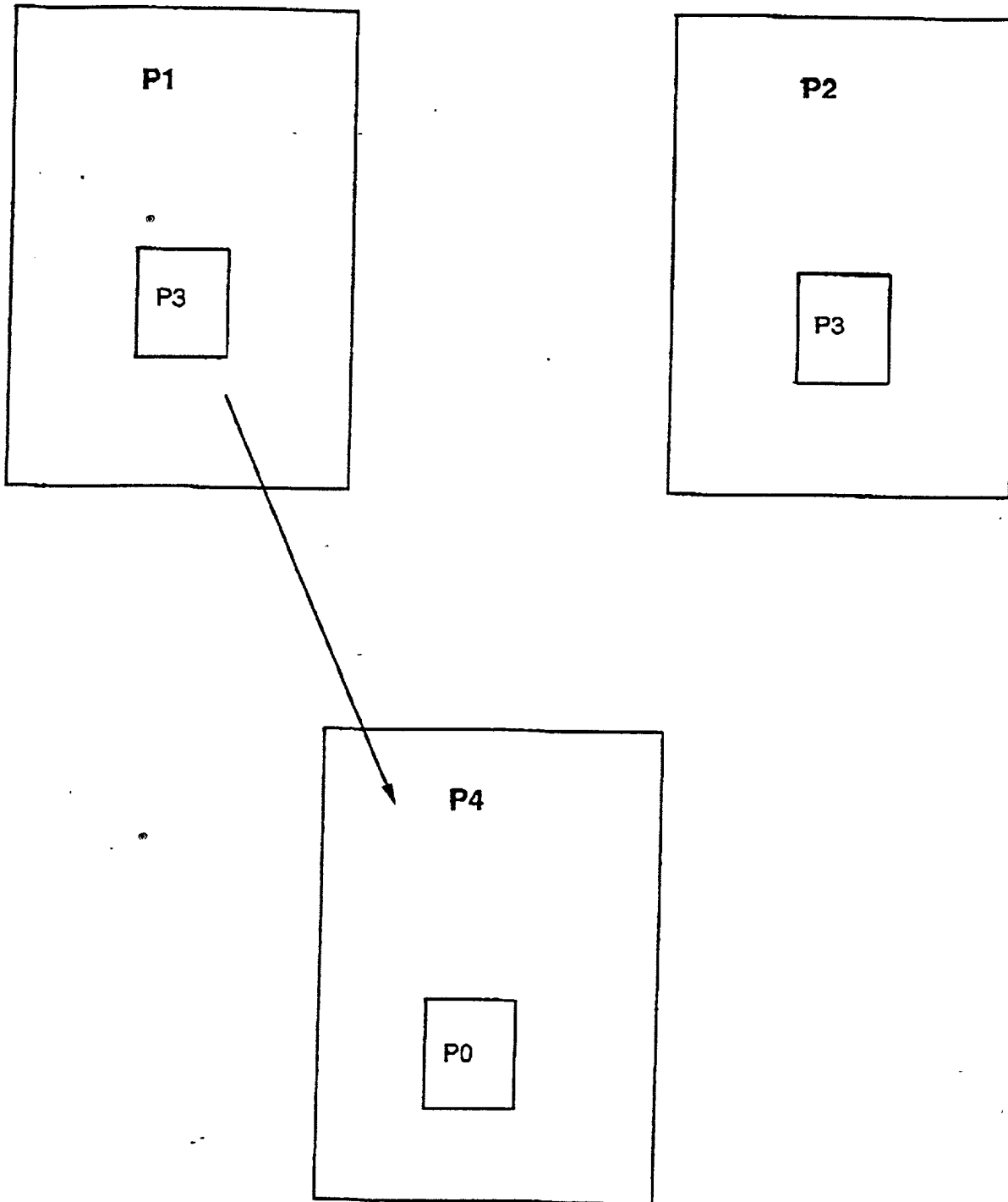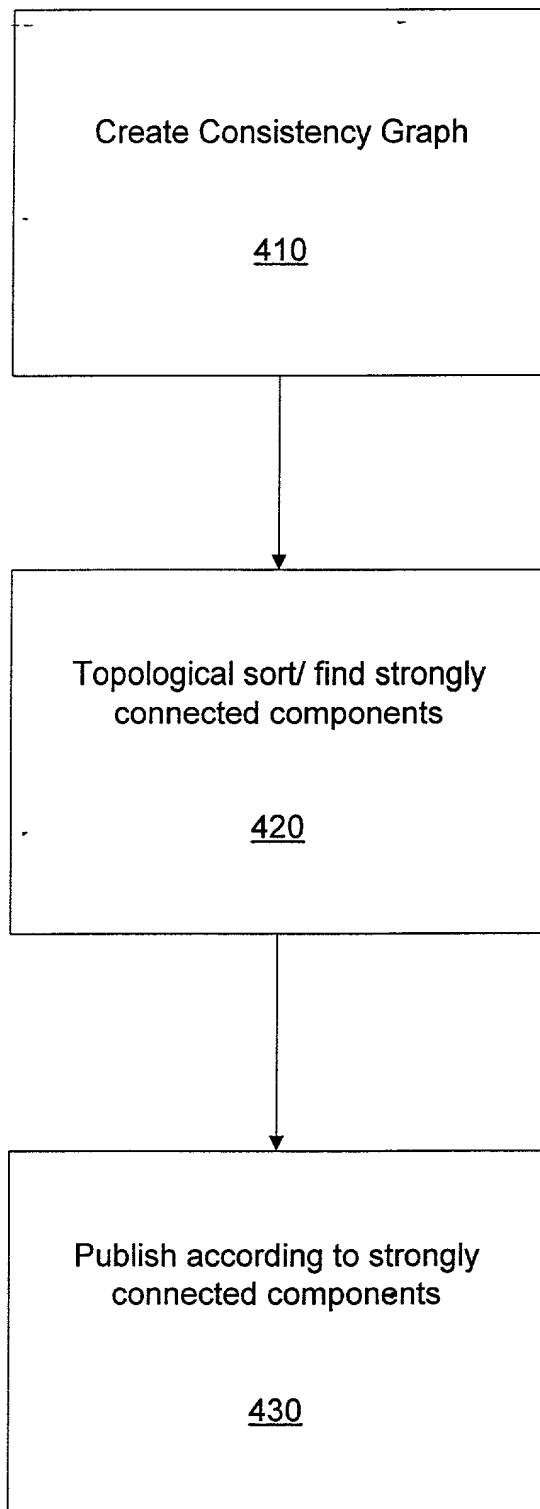
AS A BELOW NAMED INVENTOR, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe that I am the original, first and sole *(if only one name is listed below)*, or an original, first and joint inventor *(if plural names are listed below)*, of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE: METHOD AND SYSTEM FOR EFFICIENTLY CONSTRUCTING AND CONSISTENTLY PUBLISHING WEB DOCUMENTS

the specification of which either is attached hereto or indicates an attorney docket no. <u>YO999-011 (8728-255)</u>, or:

☐ was filed in the U.S. Patent & Trademark Office on _____ and assigned Serial No. _____,

☐ and *(if applicable)* was amended on _____,

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability and to the examination of this application in accordance with Title 37 of the Code of Federal Regulations §1.56. I hereby claim foreign priority benefits under Title 35, U.S. Code §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, or §119(e) of any United States provisional application(s), listed below and have also identified below any foreign applications for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Priority Claimed:

            Yes [ ]   No [ ]

(Application Number)	*(Country)*	*(Day/Month/Year filed)*

            Yes [ ]   No [ ]

(Application Number)	*(Country)*	*(Day/Month/Year filed)*

I hereby claim the benefit under Title 35, U.S. Code, §120, of any United States application(s), or §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application(s) in the manner provided by the first paragraph of Title 35, U.S. Code, §112, I acknowledge the duty to disclose information material to patentability as defined in Title 37, The Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial Number)	*(Filing Date)*	*(STATUS: patented, pending, abandoned)*

(Application Serial Number)	*(Filing Date)*	*(STATUS: patented, pending, abandoned)*

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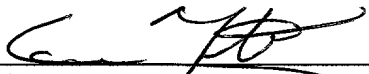
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